(54) Title: REAR-DRIVE VEHICLE WITH AN ELECTRONICALLY CONTROLLED SELF-LOCKING DIFFERENTIAL
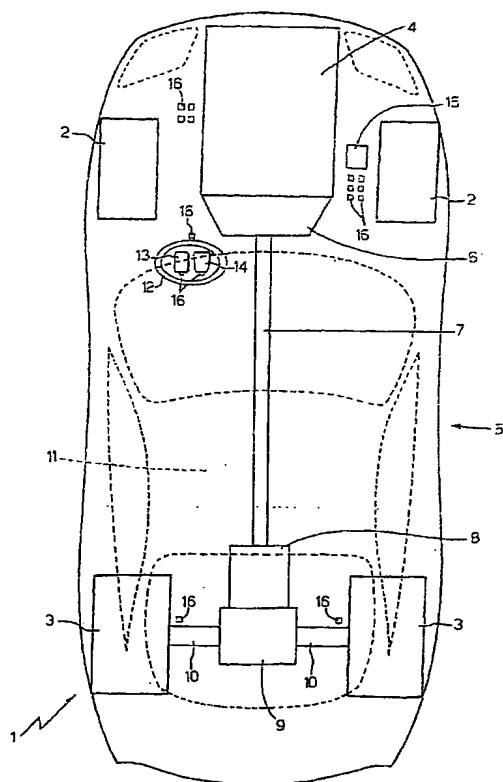
(57) Abstract: A rear-drive vehicle (1) having a self-locking differential (9); a regulating device (24)for regulating the lock percentage (%L) of the differential (9); a number of sensors (16) for real-time detecting dynamic parameters of the vehicle (1); and a central control unit (15) for controlling the regulating device (24) to regulate the lock percentage (%L) of the differential (9) as a function of the dynamic parameters of the vehicle (1).

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REAR-DRIVE VEHICLE WITH AN ELECTRONICALLY CONTROLLED SELF-LOCKING DIFFERENTIAL

10   TECHNICAL FIELD

The present invention relates to a rear-drive vehicle with a self-locking differential.

BACKGROUND ART

At present, high-performance road sports cars are
15 normally rear-drive, and have a self-locking differential for increasing the drive torque transmitted by the rear wheels to the road surface.

Tests have shown, however, that currently marketed self-locking differentials do not always succeed in
20 maximizing the drive torque transmitted by the rear wheels to the road surface. What is more, the presence of the self-locking differential makes the vehicle harder and less safe to drive, in that, should one of the rear wheels temporarily lose grip, the self-locking
25 differential almost immediately transfers part of the drive torque to the other rear wheel, thus possibly resulting in rear-end swerving of the vehicle, which must be skilfully counteracted by the driver acting promptly

on the vehicle controls to prevent the vehicle spinning.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a rear-drive vehicle featuring a self-locking
5 differential, being cheap and easy to produce, and, at the same time, eliminating the aforementioned drawbacks.

According to the present invention, there is provided a rear-drive vehicle featuring a self-locking differential, as claimed in Claim 1.

10 BRIEF DESCRIPTION OF THE DRAWINGS

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic plan view of a rear-drive
15 vehicle in accordance with the present invention;

Figure 2 shows an operating diagram of a self-locking differential of the Figure 1 vehicle;

Figure 3 shows a control method implemented by a central control unit of the Figure 1 vehicle;

20 Figure 4 shows a further control method implemented by a central control unit of the Figure 1 vehicle.

BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1 indicates a vehicle having two front wheels 2 and two rear drive wheels 3, and
25 comprising a front internal combustion engine 4 producing a drive torque Tm which is transmitted to rear drive wheels 3 by a power train 5. Power train 5 comprises a clutch 6 housed in a casing integral with engine 4 and

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for connecting the drive shaft of engine 4 to a propeller shaft 7 terminating in a mechanical gearbox 8 at the rear; and a self-locking differential 9 is cascade-connected to gearbox 8, and from which extend two axle shafts 10, each integral with a respective rear drive wheel 3.

The passenger compartment 11 of vehicle 1 houses a steering wheel 12 for imparting a turning angle Dvol to front wheels 2; a brake pedal 13 controlling a braking system to generate a braking torque on wheels 2 and 3; and an accelerator pedal 14 for regulating the drive torque Tm generated by engine 4.

Vehicle 1 comprises a central control unit 15 connected to a number of sensors 16 distributed inside vehicle 1 to real-time detect respective parameters of vehicle 1, such as the travelling speed V of vehicle 1, the turning angle Dvol of vehicle 1, the yaw speed Psip of vehicle 1, the lateral acceleration Ay of vehicle 1, the longitudinal acceleration Ax of vehicle 1, the rotation speed WrearL, WrearR of each rear drive wheel 3, the position Pacc of accelerator pedal 14, the position Pbra of brake pedal 13, and the drive torque Tm generated by engine 4. Central control unit 15 may obviously be defined by a number of physically separate processing units connected to one another, for example, by a data BUS; and, as opposed to a physical sensor 16, an estimation algorithm may be implemented by central control unit 15 to determine one or more parameters of

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vehicle 1.

As shown in Figure 2, self-locking differential 9 comprises a box body 17; a bevel gear pair 18 housed inside box body 17, and which transmits drive torque Tm
5 to the two rear drive wheels 3 via respective axle shafts 10; and a lock device 19 for partly locking one axle shaft 10 with respect to box body 17. More specifically, lock device 19 comprises a clutch 20 having a thrust chamber 21 filled with pressurized oil 22, and a number
10 of disks 23 integral with one of axle shafts 10. When thrust chamber 21 is filled with pressurized oil 22, disks 23 are subjected to axial thrust substantially proportional to the pressure P of oil 22 inside thrust chamber 21.

15 Lock device 19 of differential 9 is connected to a regulating device 24 for regulating the lock percentage %L of differential 9 between zero and a maximum value (e.g. 50%) by regulating the pressure P of oil 22 inside thrust chamber 21. In actual use, central control unit 15
20 commands regulating device 24 to regulate the lock percentage %L of differential 9 as a function of the dynamic parameters of vehicle 1.

Regulating device 24 comprises a tank 25 of oil 22 at atmospheric pressure, from which extends a pipe 26
25 fitted with a pump 27 and a non-return valve 28 to feed pressurized oil 22 to a hydraulic accumulator 29; and hydraulic accumulator 29 communicates along a pipe 30 with an inlet of a proportional solenoid valve 31, from

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which extend a pipe 32 terminating inside thrust chamber 21, and a pipe 33 terminating in tank 25. In actual use, solenoid valve 31 keeps thrust chamber 21 isolated from tank 25 to maintain a constant pressure P of oil 22

5   inside thrust chamber 21, connects thrust chamber 21 to tank 25 to reduce the pressure P of oil 22 inside thrust chamber 21, and connects thrust chamber 21 to hydraulic accumulator 29 to increase the pressure P of oil 22 inside thrust chamber 21.

10   Solenoid valve 31 is driven by a power supply 34 controlled by central control unit 15 to supply a variable voltage to the terminals of a control coil 35 of solenoid valve 31 so that an electric current I circulates through control coil 35. To ensure solenoid

15   valve 31 is activated correctly, regulating device 24 comprises a sensor 36 for detecting the value of pressure P of oil 22 inside thrust chamber 21, and a sensor 37 for detecting the value of current I circulating through control coil 35 of solenoid valve 31.

20   In actual use, central control unit 15 controls regulating device 24 by controlling power supply 34 to regulate the pressure P of oil 22 inside thrust chamber 21 as described above, and so regulate the axial thrust exerted on disks 23 of clutch 20 and, hence, the lock

25   percentage %L of differential 9. As shown in Figure 3, a target value %Lrif of the lock percentage of differential 9 is established in central control unit 15 as described later on, and is translated into an equivalent target

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value Prif of pressure P of oil 22 inside thrust chamber
21; target value Prif is compared with the actual value
of pressure P, measured by sensor 36, to generate a
pressure error E_P, from which a target value Irif of the
current I circulating through coil 35 is determined by a
PID regulator 38. Target value Irif is compared with the
actual value of current I, measured by sensor 37, to
generate a current error E_I which is used by a PID
regulator 39 to control power supply 34. In other words,
central control unit 15 controls the value of pressure P
of oil 22 inside thrust chamber 21 by means of a first
control loop employing as a feedback variable the value
of pressure P of oil 22 inside thrust chamber 21, and a
second control loop within the first control loop and
employing as a feedback variable the value of current I
circulating through coil 35 of solenoid valve 31.

An alternative embodiment comprises two torque
sensors 16, each connected to central control unit 15 and
fitted to a respective axle shaft 10 to real-time detect
the value of the torque transmitted by self-locking
differential 9 to respective rear wheel 3 via relative
axle shaft 10. Each torque sensor 16 is preferably
electromagnetic, and measures the torsional deformation
of respective axle shaft 10 electromagnetically to
determine the value of the torque transmitted by axle
shaft 10 to relative rear wheel 3.

Central control unit 15 controls regulating device
24 to regulate the lock percentage %L of differential 9

as a function of the value of the torque transmitted by
self-locking differential 9 to each rear wheel 3. More
specifically, central control unit 15 predicts time
changes in the angular rotation speed of each rear wheel
5 3, using the value of the torque transmitted by
respective axle shaft 10, and controls regulating device
24 to regulate the lock percentage %L of differential 9
as a function of future time changes in the angular
rotation speed of each rear wheel 3.

10   Central control unit 15 has the advantage of
estimating a target value of the lock percentage %L of
differential 9 as a function of the dynamic parameters of
vehicle 1, of estimating a target value of the torque
transmitted by each axle shaft 10 as a function of the
15 target value of lock percentage %L of differential 9, and
of controlling regulating device 24 by means of a
feedback control loop employing as a feedback variable
the value of the torque transmitted to each rear wheel 3.
Obviously, the control loop of the torque value may
20 contain a control loop of the value of pressure P of oil
22 inside thrust chamber 21 and/or a control loop of the
value of current I circulating through coil 35.

More specifically, as shown in Figure 4, the target
value %Lrif of the lock percentage of differential 9 is
25 established in central control unit 15 as described later
on, and is compared with the actual value of lock
percentage %L of differential 9, measured by torque
sensors 16 fitted to axle shafts 10, to generate an error

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$E_{%L}$ of lock percentage. A control signal S is obtained from lock percentage error $E_{%L}$ by a PID regulator 40, and is supplied to a control block 41 to determine a corresponding target value Irif of the current I

5 circulating through coil 35. Target value Irif is compared with the actual value of current I, measured by sensor 37, to generate a current error E_I which is used by PID regulator 39 to control power supply 34. In a preferred embodiment, to the control signal S supplied by

10 PID regulator 40 is added a further contribution, which depends directly on target value %Lrif of the lock percentage of differential 9, and is supplied by a computing block 42 implementing an inverse model. In other words, the signal supplied to control block 41

15 depends on both the error in the value of lock percentage %L of differential 9 (closed-loop feedback control) and on the target value %Lrif of the lock percentage of differential 9 (direct open-loop control). This solution is employed to increase overall control response speed.

20 In other words, central control unit 15 controls the lock percentage %L of differential 9 by means of a first control loop employing the value of lock percentage %L of differential 9 as a feedback variable, and a second control loop within the first control loop and employing

25 as a feedback variable the value of current I circulating through coil 35 of solenoid valve 31.

As vehicle 1 is running, central control unit 15 determines the target value of the lock percentage %L of

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differential 9 as a function of the dynamic parameters of
vehicle 1, the position Pacc of accelerator pedal 14, the
position Pbra of brake pedal 13, the drive torque Tm, the
gear engaged, and intervention of any other electronic

5 devices on vehicle 1 (e.g. ABS, ASR and ESP). For
example, the dynamic parameters of vehicle 1 employed by
central control unit 15 to determine the target value of
the lock percentage %L of differential 9 may be; the
travelling speed V of vehicle 1, the turning angle Dvol

10 of vehicle 1, the yaw speed Psip of vehicle 1, lateral
acceleration Ay of vehicle 1, longitudinal acceleration
Ax of vehicle 1, and the rotation speed WrearL, WrearR of
each rear drive wheel 3. To determine the target value of
the lock percentage %L of differential 9, central control

15 unit 15 may also take into account the driving mode
(normal, sport, low-grip) selected by the driver of
vehicle 1.

When driving along a substantially straight route,
central control unit 15 zeroes the lock percentage %L of

20 differential 9 in normal driving mode, and gradually
increases the lock percentage %L of differential 9 in
sport mode. In addition to the mode settings made by the
driver, the discriminating factor between normal and
sport mode may be defined by the position Pacc of

25 accelerator pedal 14, the longitudinal acceleration Ax
value of vehicle 1, and/or the speed V value of vehicle
1.

When cornering, central control unit 15 gradually

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increases the lock percentage %L of differential 9 if accelerator pedal 14 is released, to stabilize vehicle 1.

When cornering, central control unit 15 gradually reduces the lock percentage %L of differential 9 if
5 accelerator pedal 14 is pressed (sharply), to maximize both stability and cornering acceleration performance of vehicle 1. More specifically, the reduction in the lock percentage %L of differential 9 is proportional to the lateral acceleration Ay of vehicle 1, the speed V of
10 vehicle 1, the drive torque Tm of engine 4, and/or the gear engaged. In this condition, central control unit 15 may also reduce the drive torque Tm of engine 4 to limit the power oversteering effect.

When cornering at substantially steady speed,
15 central control unit 15 estimates the road grip of wheels 2, 3, and accordingly zeroes the lock percentage %L of differential 9 when the road grip of wheels 2, 3 is far from the grip limit, gradually increases the lock percentage %L of differential 9 when the road grip of
20 wheels 2, 3 nears the grip limit, and reduces the lock percentage %L of differential 9 to zero when the road grip of wheels 2, 3 is almost at the grip limit. As the road grip of wheels 2, 3 nears the grip limit, central control unit 15 preferably increases the lock percentage
25 %L of differential 9 gradually in proportion to the value of lateral acceleration Ay of vehicle 1 and the value of speed V of vehicle 1.

The road grip of wheels 2, 3 is estimated as a

function of the value of turning angle Dvol of vehicle 1
and the value of lateral acceleration Ay of vehicle 1.
More specifically, central control unit 15 zeroes the
lock percentage %L of differential 9 when the value of
5   turning angle Dvol of vehicle 1 is substantially directly
proportional to the value of lateral acceleration Ay of
vehicle 1, and gradually increases the lock percentage %L
of differential 9 when no substantially direct proportion
relationship exists between the value of turning angle
10 Dvol of vehicle 1 and the value of lateral acceleration
Ay of vehicle 1.

    Operating as described above when cornering at
substantially steady speed, understeering of vehicle 1 is
eliminated when the road grip of wheels 2, 3 is far from
15 the grip limit (linear relationship between turning angle
Dvol and lateral acceleration Ay), vehicle 1 is slightly
oversteered when the road grip of wheels 2, 3 nears the
grip limit, and vehicle 1 is understeered (i.e. performs
more safely and predictably) when the road grip of wheels
20 2, 3 is almost at the grip limit.

    Tests have shown that regulating device 24, as
described above, for regulating the lock percentage %L of
differential 9 provides for improving performance,
directional stability, active safety (even at the grip
25 limit), and driving pleasure.

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CLAIMS

1) A rear-drive vehicle (1) comprising a self-locking differential (9), and a number of sensors (16) for real-time detecting respective dynamic parameters of the vehicle (1); the vehicle (1) being characterized by comprising a regulating device (24) for regulating the lock percentage (%L) of the differential (9), and a central control unit (15) for controlling the regulating device (24) to regulate the lock percentage (%L) of the differential (9) as a function of the dynamic parameters of the vehicle (1).

2) A vehicle (1) as claimed in Claim 1, wherein the self-locking differential (9) comprises a box body (17); a bevel gear pair (18) housed in the box body (17), and which transmits the drive torque (Tm) to the two rear drive wheels (3) by means of respective axle shafts (10); and a lock device (19) for partly locking one axle shaft (10) with respect to the box body (17); the lock device (19) comprising a clutch (20) in turn having a number of disks (23) integral with one of the axle shafts (10), and a thrust chamber (21) filled with a fluid (22) under pressure (P) to exert variable axial thrust on the disks (23).

3) A vehicle (1) as claimed in Claim 2, wherein the regulating device (24) regulates the pressure (P) of the fluid (22) inside the thrust chamber (21).

4) A vehicle (1) as claimed in Claim 3, wherein the

regulating device (24) comprises a solenoid valve (31) for selectively connecting the thrust chamber (21) to a tank (25) into which the fluid (22) is drained, or to a tank (29) for supplying the fluid (22) under pressure (P).

5) A vehicle (1) as claimed in Claim 4, wherein the central control unit (15) estimates a target value of the lock percentage (%L) of the differential (9) as a function of the dynamic parameters of the vehicle (1), estimates a target value (Prif) of the pressure (P) of the fluid (22) inside the thrust chamber (21) as a function of the target value of the lock percentage (%L) of the differential (9), and controls the solenoid valve (31) to apply inside the thrust chamber (21) the target value (Prif) of the pressure (P) of the fluid (22).

6) A vehicle (1) as claimed in Claim 5, wherein the regulating device (24) comprises a first sensor (36) for detecting the value of the pressure (P) of the fluid (22) inside the thrust chamber (21), and a second sensor (37) for detecting the value of the current (I) circulating through the solenoid valve (31); the central control unit (15) controlling the value of the pressure (P) of the fluid (22) inside the thrust chamber (21) by means of a first control loop employing as a feedback variable the value of the pressure (P) of the fluid (22) inside the thrust chamber (21), and a second control loop within the first control loop and employing as a feedback variable the value of the current (I) circulating through the

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solenoid valve (31).

7) A vehicle (1) as claimed in one of Claims 1 to 6, and comprising an engine (4) producing a drive torque (Tm) which is transmitted to the rear drive wheels (3) by
5   the self-locking differential (9); an accelerator pedal (14) which modulates the drive torque (Tm) generated by the engine (4); and a brake pedal (13) which modulates a brake torque acting on the vehicle (1).

8) A vehicle (1) as claimed in Claim 7, wherein the
10 central control unit (15) controls the regulating device (24) to regulate the lock percentage (%L) of the differential (9) as a function of the travelling speed (V) of the vehicle (1), the turning angle (Dvol) of the vehicle (1), the yaw speed (Psip) of the vehicle (1), the
15 lateral acceleration (Ay) of the vehicle (1), the longitudinal acceleration (Ax) of the vehicle (1), the rotation speed (WrearL, WrearR) of each rear drive wheel (3), the position (Pacc) of the accelerator pedal (14), the position (Pbra) of the brake pedal (13), and the
20 drive torque (Tm).

9) A vehicle (1) as claimed in Claim 7 or 8, wherein, when cornering, the central control unit (15) increases the lock percentage (%L) of the differential (9) when the accelerator pedal (14) is released.

25 10) A vehicle (1) as claimed in Claim 7, 8 or 9, wherein, when cornering, the central control unit (15) reduces the lock percentage (%L) of the differential (9) when the accelerator pedal (14) is pressed.

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11) A vehicle (1) as claimed in Claim 10, wherein the reduction in the lock percentage (%L) of the differential (9) is proportional to the lateral acceleration (Ay) of the vehicle (1), the speed (V) of

5   the vehicle (1), and the drive torque (Tm) of the engine (4).

12) A vehicle (1) as claimed in Claim 10 or 11, wherein the central control unit (15) reduces the drive torque (Tm) of the engine (4) to limit the power

10 oversteering effect.

13) A vehicle (1) as claimed in one of Claims 7 to 12, wherein, when cornering at substantially steady speed, the central control unit (15) estimates the road grip of the wheels (2, 3), zeroes the lock percentage

15 (%L) of the differential (9) when the road grip of the wheels (2, 3) is far from the grip limit, and gradually increases the lock percentage (%L) of the differential (9) when the road grip of the wheels (2, 3) nears the grip limit.

20   14) A vehicle (1) as claimed in Claim 13, wherein the central control unit (15) reduces the lock percentage (%L) of the differential (9) to zero when the road grip of the wheels (2, 3) is almost at the grip limit.

15) A vehicle (1) as claimed in Claim 13 or 14,

25 wherein, as the road grip of the wheels (2, 3) nears the grip limit, the central control unit (15) gradually increases the lock percentage (%L) of the differential (9) in proportion to the value of the lateral

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acceleration (Ay) of the vehicle (1) and the value of the
speed (V) of the vehicle (1).

16) A vehicle (1) as claimed in Claim 13, 14 or 15,
wherein the central control unit (15) zeroes the lock
percentage (%L) of the differential (9) when the value of
the turning angle (Dvol) of the vehicle (1) is
substantially directly proportional to the value of the
lateral acceleration (Ay) of the vehicle (1), and
gradually increases the lock percentage (%L) of the
differential (9) when no substantially direct proportion
relationship exists between the value of the turning
angle (Dvol) of the vehicle (1) and the value of the
lateral acceleration (Ay) of the vehicle (1).

17) A vehicle (1) as claimed in one of Claims 13 to
16, wherein the central control unit (15) estimates the
road grip of the wheels (2, 3) by estimating the value of
the lateral acceleration (Ay) of the vehicle (1).

18) A vehicle (1) as claimed in one of Claims 13 to
16, wherein the central control unit (15) estimates the
road grip of the wheels (2, 3) by estimating the value of
the turning angle (Dvol) of the vehicle (1) and value of
the lateral acceleration (Ay) of the vehicle (1).

19) A vehicle (1) as claimed in one of Claims 7 to
18, wherein, when driving along a substantially straight
route, the central control unit (15) zeroes the lock
percentage (%L) of the differential (9) in normal driving
mode, and gradually increases the lock percentage (%L) of
the differential (9) in sport driving mode.

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20) A vehicle (1) as claimed in one of Claims 1 to
19, and comprising two axle shafts (10), each connecting
the self-locking differential (9) mechanically to a
respective rear wheel (3); and two torque sensors (16),
5   each of which is connected to the central control unit
(15), is fitted to a respective axle shaft (10), and
real-time detects the value of the torque transmitted by
the self-locking differential (9) to the respective rear
wheel (3) via the relative axle shaft (10); the central
10 control unit (15) controlling the regulating device (24)
to regulate the lock percentage (%L) of the differential
(9) as a function of the value of the torque transmitted
by the self-locking differential (9) to each rear wheel
(3).

15   21) A vehicle (1) as claimed in Claim 20, wherein
each torque sensor (16) is electromagnetic, and measures
electromagnetically the torsional deformation of the
respective axle shaft (10) to determine the value of the
torque transmitted by the axle shaft (10) to the relative
20 rear wheel (3).

22) A vehicle (1) as claimed in Claim 20 or 21,
wherein the central control unit (15) predicts time
changes in the angular rotation speed of each rear wheel
(3), using the value of the torque transmitted by
25 respective axle shaft (10), and controls the regulating
device (24) to regulate the lock percentage (%L) of the
differential (9) as a function of future time changes in
the angular rotation speed of each rear wheel (3).

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23) A vehicle (1) as claimed in Claim 20, 21 or 22, wherein the central control unit (15) estimates a target value of the lock percentage (%L) of the differential (9) as a function of the dynamic parameters of the vehicle

5 (1), and controls the regulating device (24) by means of a feedback control loop employing as a feedback variable the value of the lock percentage (%L) of the differential (9).

24) A vehicle (1) as claimed in Claim 23, wherein

10 the regulating device (24) comprises a solenoid valve (31) controlled to vary the lock percentage (%L) of the differential (9), and a second sensor (37) for detecting the value of the current (I) circulating through the solenoid valve (31); the central control unit (15)

15 controlling the regulating device (24) by means of a first control loop employing the value of the lock percentage (%L) of the differential (9) as a feedback variable, and a second control loop within the first control loop and employing as a feedback variable the

20 value of the current (I) circulating through the solenoid valve (31).

25) A vehicle (1) as claimed in Claim 20, 21 or 22, wherein the central control unit (15) estimates a target value of the lock percentage (%L) of the differential (9)

25 as a function of the dynamic parameters of the vehicle (1), and controls the regulating device (24) by adding a feedback control loop employing the value of the lock percentage (%L) of the differential (9) as a feedback

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variable, and a direct open control loop employing the
target value of the lock percentage (%L) of the
differential (9) as a control variable.

26) A vehicle (1) as claimed in Claim 25, wherein
the regulating device (24) comprises a solenoid valve
(31) controlled to vary the lock percentage (%L) of the
differential (9), and a second sensor (37) for detecting
the value of the current (I) circulating through the
solenoid valve (31); the central control unit (15)
controlling the regulating device (24) by means of a
first control loop employing the value of the lock
percentage (%L) of the differential (9) as a feedback
variable, and a second control loop within the first
control loop and employing as a feedback variable the
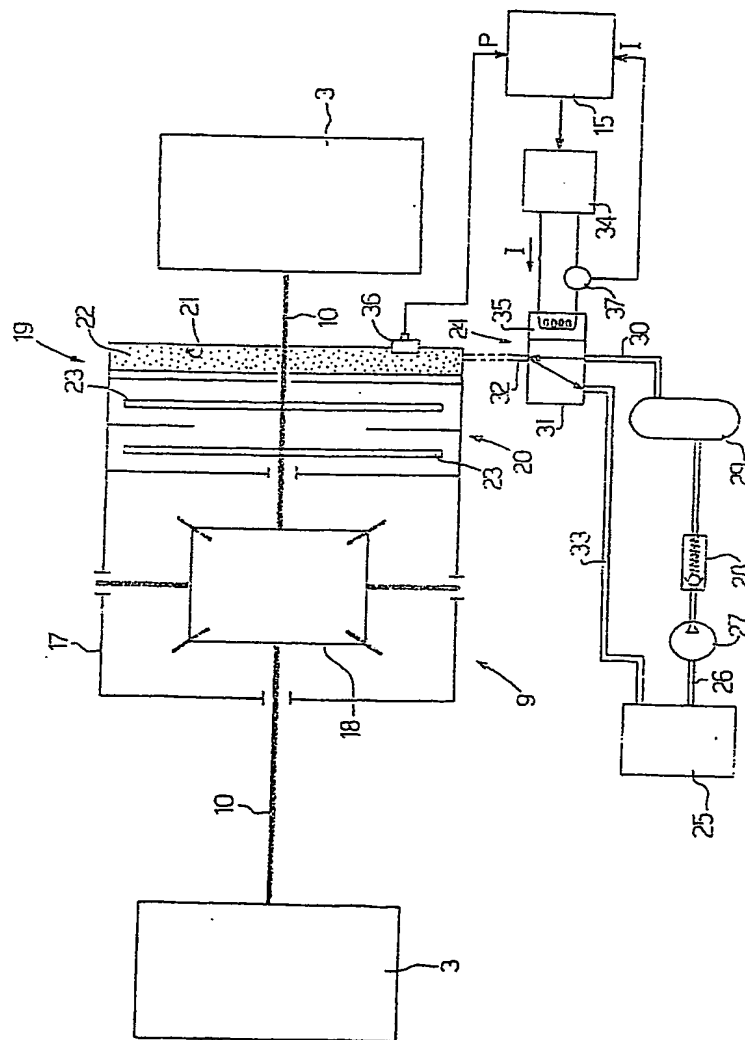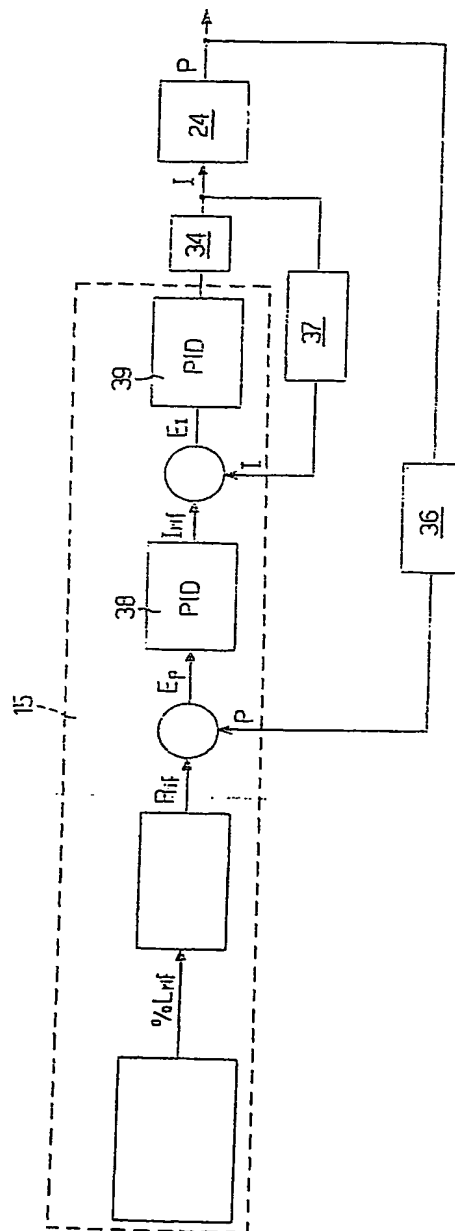value of the current (I) circulating through the solenoid
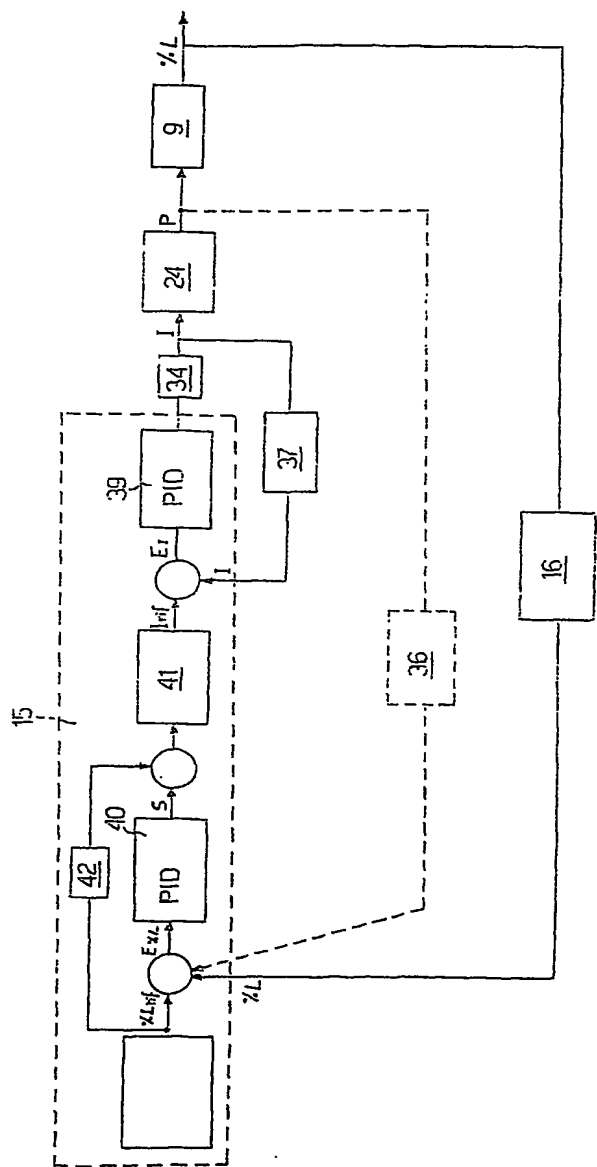valve (31).

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Fig.1
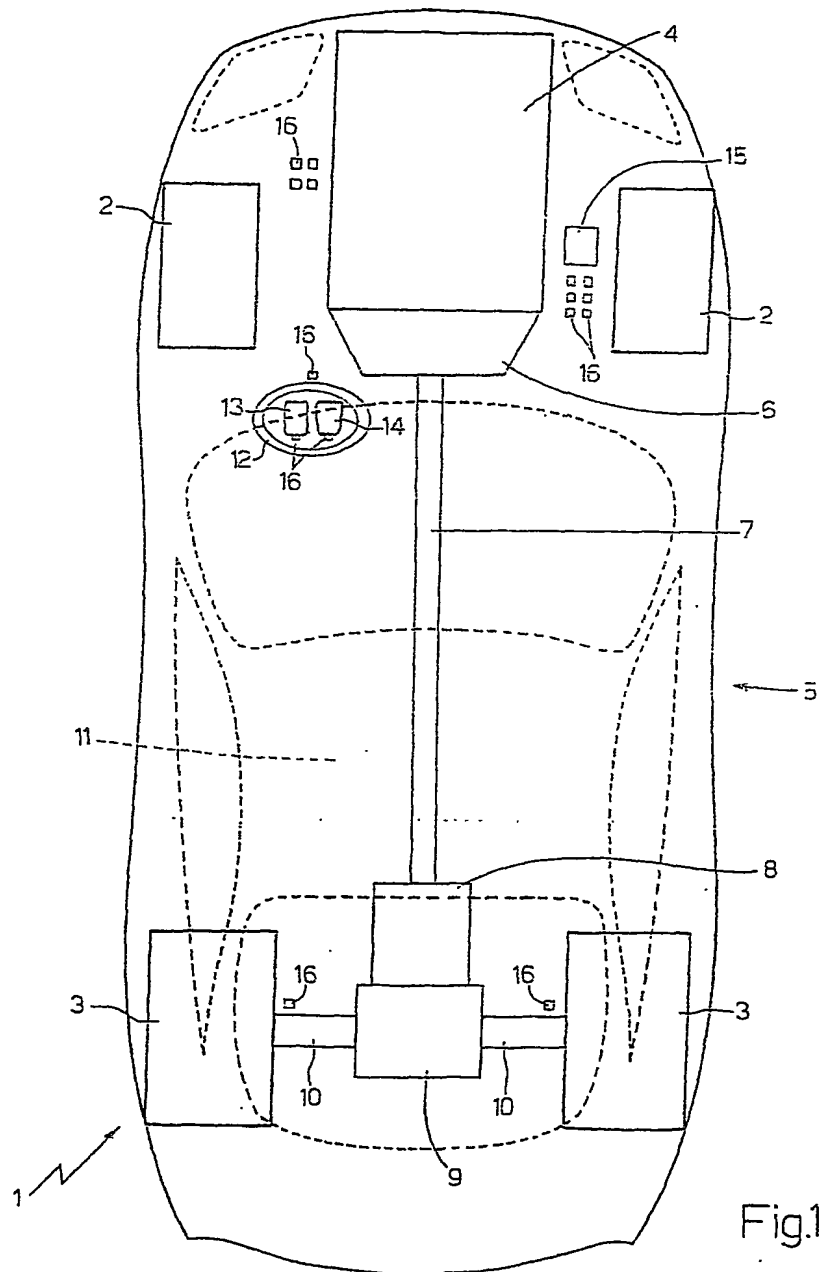
Fig.2

Fig.3

Fig.4

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   B60K17/16   F16H48/30

CORRECTED VERSION

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   B60K   F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 36 37 820 A (NISSAN MOTOR) 14 May 1987 (1987-05-14) column 6, line 21 - line 29 column 7, line 9 - line 47	1-8
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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

28 September 2004

Date of mailing of the international search report

30 09. 2004

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Form PCT/ISA/210 (second sheet) (January 2004)

International Application No
PCT/EP2004/050434

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